THIRD FIVE-YEAR REVIEW REPORT FOR
VINELAND CHEMICAL COMPANY SUPERFUND SITE
CUMBERLAND COUNTY, NEW JERSEY

Prepared by

U.S. Environmental Protection Agency
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Pat Evangelista, Director **Date**
Superfund and Emergency Management Division

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LIST OF ABBREVIATIONS & ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
EPA	United States Environmental Protection Agency
FYR	Five-Year Review
ICs	Institutional Controls
MCL	Maximum Contaminant Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
PRP	Potentially Responsible Party
RAO	Remedial Action Objectives
ROD	Record of Decision
RPM	Remedial Project Manager
TBC	To Be Considered

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

This is the third FYR for the Vineland Chemical Company Superfund Site (Site), located in the City of Vineland, Cumberland County, New Jersey. The U.S. Environmental Protection Agency (EPA) is preparing this five-year review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 U.S.C. §9601 et seq. and 40 CFR 300.430(f)(4)(ii), and in accordance with the Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P (June 2001). This report will become part of the Site file.

The triggering action for this discretionary review is the completion date of the previous FYR. The FYR has been prepared due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The Site consists of six operable units (OUs), and three OUs will be addressed in this FYR. OU1 is defined as Plant Site Source Control, OU2 deals with Groundwater/Plant Site Management of Migration of Arsenic Contaminated Groundwater to the Blackwater Branch and OU3 is defined as River Areas Sediment (Blackwater Branch and Maurice River). OU4, which addresses Union Lake, is not included in the FYR since the remedy for this OU has not yet been implemented. OU5 involved on-site building demolition in 1994 and was completed in 1994. OU6 is an OU at the beginning of the RI/FS process in FY21 and will not be reviewed in this document. OUs 1, 2 and 3 are included in this FYR.

The Vineland Chemical Company Superfund Site Five-Year Review was led by Nica Klaber, the EPA Remedial Project Manager. Participants included Abbey States (Human Health Risk Assessor), Kathryn Flynn (Geologist), Abigail DeBofsky (Ecological Risk Assessor) and a team from the United States Army Corps of Engineers (USACE) Philadelphia District. The review began on 12/2/2020.

Site Background

The Vineland Chemical Company plant site is located in a mixed residential/industrial area in the northwest corner of the City of Vineland in Cumberland County, New Jersey. The plant site location is shown in Figure 1. Contaminated media include plant site soil, the underlying groundwater, approximately seven miles of stream/river corridor and downstream Union Lake.

Vineland Chemical Company began manufacturing organic arsenical herbicides and fungicides at the Vineland, New Jersey site in approximately 1949. The site was placed on the National Priorities List in 1984, and all site production activities ceased in 1994. Based on information presented in the 1989 EPA Record of Decision (ROD) for the Vineland site, the herbicide manufacturing process reportedly produced approximately 1,107 tons of waste by-product salts each year, which were improperly stored until 1978. The improper storage of these salts on the plant property led to arsenic contamination in the soil and groundwater at the Plant Site, and arsenic contamination in surface water and soil/sediment downstream from the plant.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Vineland Chemical Company		
EPA ID: NJD002385664		
Region: 22	**State:** NJ	**City/County:** Vineland/Cumberland
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): Nica Klaber		
Author affiliation: Remedial Project Manager		
Review period: 07/01/2016- 12/30/2020		
Date of site inspection: 1/25/2021		
Type of review: Discretionary		
Review number: 3		
Triggering action date: 9/26/2016		
Due date *(five years after triggering action date*): 9/26/2021		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

Remedial action at this Site is necessary to protect human health and the environment from actual and potential releases of hazardous substances from the Site into the environment. Improper plant practices released contaminants to the environment. A Remedial Investigation/Feasibility Study (RI/FS) was completed for the Site in June 1989.

The purpose of the RI/FS was to identify the types, quantities, and locations of site-related contaminants. The overall findings of the RI/FS were that site-related arsenic contamination extended from the plant soil and underlying groundwater, to the Maurice River and Union Lake downstream of the plant to the Delaware Bay. More specifically, the RI found:

<u>Vineland Chemical Plant Site</u>

- On-site soil above the water table was significantly contaminated with arsenic in certain areas.
- On-site areas used for arsenic waste salt storage were also found to be highly contaminated.

<u>Groundwater</u>

- Residual soil beneath the water table was impacted by arsenic leaching from the plant site soil.
- The shallow groundwater beneath the site was contaminated with arsenic, and contaminated to a lesser degree with cadmium and trichloroethylene (TCE), which were later reported at non-detect concentrations and not further evaluated.

<u>Blackwater Branch and River Areas</u>

- Sediment and surface water in the Blackwater Branch had elevated arsenic concentrations downstream of the plant site, while having low to non-detectable concentrations upstream of the plant.
- Sediment and surface water in the Maurice River below, but not above, its confluence with the Blackwater Branch had elevated arsenic concentrations.
- Approximately six metric tons of arsenic per year entered the Blackwater Branch via groundwater flowing from the plant towards the branch.

<u>Union Lake</u>

- Arsenic contamination in sediment is found in portions of the lake. Contamination is primarily associated with fine-grained deposits present in sediment with highly variable concentrations (undetected to elevated levels). Select location-specific surface water results showed elevated arsenic concentrations.

A baseline human health risk assessment was conducted as part of the RI and indicated the potential for unacceptable risks from direct contact with arsenic-contaminated soil by hypothetical future workers or residents, from ingestion of arsenic-contaminated groundwater associated with potential future use of groundwater as a potable water source, from direct contact with arsenic-contaminated sediment in the Blackwater Branch and the upper Maurice River, and from ingestion of fish from the upper Maurice River due to arsenic in fish tissue. Arsenic was the only contaminant of concern identified at the Site.

No ecological risk assessment was performed as part of the RI/FS.

<u>**Response Actions**</u>

As early as 1966, the New Jersey Department of Health observed Vineland Chemical Company discharging untreated wastewater with elevated arsenic concentrations into the unlined lagoons. An unknown quantity of arsenic rapidly infiltrated to the groundwater from the lagoons. On February 8, 1971, Vineland Chemical was ordered to provide industrial wastewater treatment and/or disposal facilities. The wastewater treatment works did not become operational until March 1980.

Waste salts from the herbicide production process were stored on-site in uncontrolled piles on the soil, which were unlined at the time, and in abandoned chicken coops on the plant property. The storage of salts in piles was observed in April 1970 and in the coops in April 1973. It was not until 1978, after numerous court orders, that the salts were containerized and removed. These salts reportedly contained one to two percent arsenic based on a Resource Conservation and Recovery Act (RCRA) Part B Permit Application, 1980. Since these salts have a high solubility, precipitation contacting these piles rapidly dissolved the salts and carried an unknown quantity of arsenic into the groundwater.

Between 1975 and 1976, Vineland Chemical was "fixating" the waste salts for disposal at the Kin-Buc Landfill. The process involved mixing the dried salts with ferric chloride and soda ash, reportedly reducing the solubility. The process was stopped in 1976 when the Kin-Buc Landfill voluntarily stopped accepting all chemical wastes, including the fixated salts. The company then resumed stockpiling the untreated waste salts on the soil surface at the plant site.

A court order issued on January 26, 1977 required Vineland Chemical to containerize the waste salts from the chicken coops and piles, and then store the drums in a warehouse off-site. In June 1979, another court order was issued for the disposal of the stored drums in an approved landfill. Removal and disposal of these drums were not completed until June 30, 1982.

Aerial photographs provided by EPA's Environmental Photographic Information Center (EPIC) as well as conversations with Vineland Chemical Company employees indicated several possible locations of historic contamination. A cleared area in the southwest corner of the site was previously occupied by two chicken coops. Sometime between November 1975 and March 1979, both coops were destroyed. These coops were reportedly used to store process chemicals and/or waste in the early 1970s. The materials stored in the coops may have percolated into the groundwater. Photographs showed many locations containing mounded material and/or drums. These were observed in the lagoon area and along the plant road. The floors of the manufacturing buildings may also have been leaking arsenic compounds into the underlying sands for years. The original floors of the buildings were brick and were reportedly in need of repair. When the old bricks were removed, the underlying soil was said to have contained crystalline waste from previous spills. It is not known whether the soil was removed when the floors were replaced.

In response to a series of Administrative Consent Orders issued by NJDEP, Vineland Chemical instituted some cleanup actions and modified its production process. The cleanup actions included stripping the surface soil in the manufacturing area and paving this area; installing a storm water runoff collection system; removing the piles of waste salts; and installing a groundwater pump and treat system. Modifications to the production process included altering the water system so that mixing of process water and non-contact cooling water was unlikely, lining two of the lagoons used in the wastewater treatment system, and properly disposing of the waste salts off-site. The lining has since been removed from these lagoons and the entire area has been excavated.

Potentially responsible parties (PRPs) identified for the site include the Vineland Chemical Company and its owners. EPA signed an Administrative Order on Consent with the Vineland Chemical Company on September 28, 1984 allowing the company to conduct a remedial investigation of the site pursuant to CERCLA. Vineland Chemical submitted Remedial Investigation and Feasibility Study (RI/FS) Work Plan drafts which required major revisions. The company failed to submit a draft work plan incorporating the modifications that EPA required. As the revised work plan was not submitted in a timely manner EPA assumed responsibility for the RI/FS on May 8, 1986. After the RI/FS was completed, a Proposed Plan was issued in 1989.

Remedial Action Objectives and Selected Remedy

The ROD was signed on September 28, 1989, which divided the site into four OUs (Figure 2) and selected a remedy for each of them. The Remedial Action Objective (RAOs) and selected remedy for each OU as described in the 1989 ROD are as follows:

OU1:
RAO: Prevent current or future exposure to the contaminated site soil and reduce arsenic migration into the groundwater

Selected Remedy:

- In situ treatment, by flushing, of the arsenic-contaminated soil to reduce the arsenic concentration, with excavation and consolidation of portions of contaminated soil prior to flushing.
- Closure of the two lined surface impoundments in compliance with Resource and Conservation Recovery Act (RCRA) standards and decontamination of the former chicken coop storage buildings

OU2:
RAO: Achieve an aquifer cleanup goal of 0.05 milligram per liter (mg/l) of arsenic to the maximum extent technically practicable, and minimize the flow of arsenic-contaminated groundwater to Blackwater Branch.

Selected Remedy:

- Removal of arsenic-contaminated groundwater through pumping, followed by on-site treatment and reinjection of the treated groundwater to the aquifer at the maximum rate practicable
- Use of a portion of the treated groundwater for the soil flushing action in OU1, with discharge of the remainder of the treated groundwater to the Maurice River.
- Transportation off-site of the arsenic-contaminated sludge from the groundwater treatment process for hazardous waste treatment and disposal.

OU3:
RAO: Minimize public exposure, either through containment, removal or institutional controls, to those areas with unacceptably high sediment arsenic concentrations, such as those in the Blackwater Branch floodplain.

Remedy:

- Excavation and treatment via water wash extraction of the exposed arsenic-contaminated sediment in the Blackwater Branch floodplain; placement of the treated sediment in the excavated portion of the floodplain; and transportation off-site of the sludge from the extraction process for hazardous waste treatment and disposal. Remediation will begin after the contaminated groundwater flow into the Blackwater Branch has been stopped.
- Dredging/removal and treatment, by water wash extraction, of the submerged arsenic-contaminated sediment in the Blackwater Branch adjacent to and downstream of the Vineland Chemical Company plant site, after completion of an environmental assessment of the impact of the dredging and a confirmation that this sediment is a source of contamination to the river system; placement of the treated sediment on the undeveloped areas of the Vineland Chemical

Company plant site; and transportation off-site of the sludge from the extraction process for hazardous waste treatment and disposal.

- After stopping the flow of arsenic-contaminated groundwater from the Vineland Chemical Company plant site a three year period for natural river flushing will be implemented to allow for the submerged, arsenic-contaminated sediment of the Maurice River to be flushed clean through natural processes. If, after this period, the submerged sediment is no longer contaminated with arsenic above the action level, no remediation will be performed in the river. Similarly, if sediment contamination above the action level persists, but the observed or expected natural decontamination rate is consistent with an acceptable public health risk, no remediation will be performed. If contamination above the action level persists in some locations and is expected to remain at levels posing unacceptable health risk, those locations would be remediated.

<u>OU4:</u>
RAO: Reduce potential human health risks by minimizing public exposure to sediment in Union Lake with unacceptably high arsenic concentrations, either through removal, containment or institutional controls.

Interim Remedy:

- Removal and treatment of arsenic-contaminated sediment on the periphery of Union Lake will be performed after the three year flushing period (if no remediation is performed in the Maurice River) or after remediation of the Maurice River (if this is necessary following the flushing period), with verification sampling prior to remediation to confirm the locations of sediment contaminated above the action level for arsenic along the periphery of Union Lake.

- Any work on OU4 Union Lake is on hold until the Maurice River work is resolved.

Two additional OUs have been created since the signing of the 1989 ROD. These are described as follows:

<u>OU 5:</u>
The 1989 ROD included some additional activities to be performed during the design phases of the remedies. These activities included determining the full extent of arsenic contamination underneath the buildings and paved manufacturing areas of the Vineland Chemical Company plant site.
During the design phase, borings were advanced through the floors of all the plant buildings and paved areas. Samples were also collected from inside the buildings including the walls, floors, ceilings and equipment. Significant amounts of arsenic were discovered in some of the buildings and in the soils under the buildings at depths down to the water table. Arsenic was found at a level of 2,530 ppm below building 3; 158 ppm in the subsurface soils under building 7 (laboratory); 1,530 ppm below building 8; 11,100 ppm in the brick flooring under building 9; 5,650 ppm below building 10; 72 ppm in the subsurface soils under building 5 (boiler plant); 334 ppm below the wastewater treatment plant; and 508 ppm in the wood framing of a chicken coop.

Based on these findings, in 1994 EPA decided to demolish and dispose of eight buildings on the plant site that were themselves contaminated with arsenic or were constructed over contaminated soils that need to be remediated. Because the arsenic had permeated the building materials, decontamination was not considered to be a viable option. Remediating the contaminated buildings eliminated the human health risk associated with exposure to contaminated building interiors. In addition, removal of the buildings provided access to the contaminated soils below which were addressed as part of the Operable Unit 1 remedy. OU5 was completed in 1994. The change was memorialized in an Explanation of Significant Differences (ESD) signed in 1997 and described below.

OU6:

The anticipated start date of OU6 RI field work will be in 2022. OU6 was created in 2020 in order to address the concerns raised in the 2016 ROD Amendment described below. OU6 will take a holistic view of the site, as this OU encompasses the interactions between groundwater and the saturated soil containing arsenic that originated from the former Vineland Chemical Company operations. The arsenic in the subsurface soil comprises an on-going source of arsenic to porewater, groundwater, soil, sediment, and surface water associated with OU3 (BWB).

Explanations of Significant Differences

1997 ESD

EPA determined that since the Vineland Chemical Company could not effectively undertake the preliminary remedial investigation work, the company would not be given the option to perform the remedial design work. Instead, EPA proposed to use its enforcement authority to ensure that the PRPs funded the remedial work to the maximum extent possible. Following the death of the owner in October 1990, operations at the Vineland Chemical Company facility began to slow down.

In 1992, EPA assessed the plant site conditions after being informed by the plant manager that the Vineland Chemical Company site would be abandoned. There were thousands of gallons of arsenic solutions stored in tanks and containers on the site. In June 1992, EPA secured the buildings and installed fences around soil areas containing high levels of arsenic. In addition, a fence was installed around the plant site to restrict trespassers. Removal of the hazardous materials stored in tanks and containers began in the fall of 1992. The company ceased operations and the plant site buildings were abandoned in early 1994.

As described above, significant quantities of arsenic were discovered in some of the buildings and in the soil at depths down to the water table. It was found that arsenic had permeated the building materials and that decontamination of these materials would not be effective, so the buildings were demolished in 1994. Based on this, on June 26, 1997, EPA approved an ESD which included the demolition and disposal of the plant site buildings and debris. The ESD also included an increase in volume of the contaminated plant site soil and changes in the groundwater treatment plant size and treatment process.

2001 ESD

In August 2001, another ESD changed the OU1 in-situ soil flushing remedy to ex-situ soil washing, based on the results of treatability studies that concluded soil washing was more effective at reducing arsenic concentrations to the cleanup goal of 20 mg/kg. The soil washing facility operated on the site from 2005 until 2007, and cleaned over 400,000 tons of contaminated soil. Approximately 94 percent of the washed soil met residential cleanup criteria and was later returned to the excavated areas. The remaining soil was disposed of off-site at an appropriate facility.

OU3 ROD Amendment

After implementation of the Blackwater Branch portion of the OU3 remedy, sampling showed that soil/sediment in specific exposed portions of the floodplain had been re-contaminated. Since implementation of the original OU3 remedy, new information has been collected to support a change from the technology selected in the 1989 ROD.

This information is summarized briefly as follows:

- Sediment samples collected between 2010 and 2015 demonstrated that groundwater that is discharging to the Blackwater Branch floodplain in certain areas is re-contaminating the sediment/soil in isolated areas.

- New information collected as part of an optimization study on the pump-and-treat system completed in 2011 found that the groundwater pump-and-treat system provided reasonably good containment, but that concentration reduction rates had slowed to asymptotic conditions over the past 10 years. It was recommended that due to existing geochemical conditions, active in-situ treatment for arsenic immobilization could play an important role in cost effectively containing the groundwater plume.

- Bench scale studies and pilot tests of in-situ treatment technologies were conducted. Thus far, in-situ treatment has been shown to effectively prevent recontamination of the sediment/soil of the Blackwater Branch floodplain, and is expected to be effective in other parts of the impacted floodplain.

- A screening level human health risk assessment was conducted for the Blackwater Branch, which concluded that remaining concentrations of arsenic accumulating in Area A (see Figure 4) in the floodplain are associated with unacceptable levels of risk for recreators.

The major components of the 2016 ROD Amendment for OU3 included:

- Installation of in-situ treatment technologies (air sparge) to prevent recontamination of the exposed sediment/soil to concentrations above Remediation Goals.
- Excavation of localized areas of sediment/soil in the Blackwater Branch floodplain with concentrations of contaminants above Remediation Goals.
- Performance monitoring to assure the remedy is effective and assess the need for additional in-situ treatment and/or excavation.

This was considered an interim remedial action that will be revisited at a future date once the long-term effectiveness as a part of the remedy for all operable units of the site is evaluated. This evaluation of the long-term effectiveness of the interim remedial action is being conducted as part of OU6, as described above.

Cleanup Goals

The cleanup goals for arsenic identified in the 1989 ROD and maintained in the 1997 and 2001 ESDs and the 2016 ROD Amendment, except as noted, are:

Medium	Cleanup Goal
Soil	20 mg/kg
Exposed soil/Sediment	20 mg/kg / 19 mg/kg[1]
Submerged Sediment	120 mg/kg[3]
Groundwater	50 ug/L

Groundwater discharging into the Blackwater Branch	350 ug/L [2]
Surface Water	50 ug/L

[1] The 2016 OU3 ROD Amendment changed the cleanup goal for arsenic in the exposed sediment to 19 mg/kg, which is consistent with the current New Jersey Residential Direct Contact Cleanup Standard. The standard was revised to be consistent with statewide background concentrations of naturally occurring arsenic in soil.

[2]A criterion for discharge to surface water (referred to as an "Alternative Concentration Limit" in the 1989 ROD) was identified for the groundwater at this interface, based on the expectation that the MCL may not be reached by pumping and treating. In that instance, this criterion would be met through active remediation, followed by allowing the aquifer to naturally flush to reduce the arsenic concentration to the MCL.

[3]The 1989 ROD health-based target cleanup level (for OU3 and OU4) is 120 mg/kg, but is reduced to 20 mg/kg in more accessible areas such as Almond Beach and the Blackwater Branch floodplain. The sediment cleanup goal in Union Lake is 120 mg/kg in specific, less accessible, portions of the lake.

Status of Implementation

OU1:

The following response actions were taken as part of the OU1 remedy:

Soil washing treatability studies were initiated in 2000. The soil washing pilot studies were completed in early 2002 and the design of the soil washing treatment plant (SWTP) was completed in late 2002, with construction completed in 2003.The excavation and treatment of arsenic contaminated OU1 soil began in late 2003. The treated soil was sampled for arsenic, confirmed clean (<20 ppm total arsenic) and backfilled into the excavated areas. Excavation of the OU1/Plant Site area continued through August 2006, with a total of 411,779 tons of soil processed through the SWTP, successfully treated, and backfilled onto the site. The excavation depths ranged from 2-3 feet along the site perimeter to up to 15 feet in the center of the old plant site. The water table depth ranged from 10'-15' below ground surface, resulting in some of the excavated soil originating from below the water table. At some locations, soil was excavated from as much as 4 ft below the water table. Remediation of the old Plant Site was substantially completed in August 2006, with the exception of a small amount of remaining contaminated soil in the center of Area 5 which was to remain in place as a "staging/dewatering area" for excavated OU3/Phase I sediment until the OU3/Phase I remediation was completed. The total amount of soil treated in Areas 1 – 5 of the OU1 remedy was approximately 270,779 tons.

Note that, after the removal of 107,498 tons of contaminated soil, some samples, located 4 ft below the water table, remained contaminated; it was determined that excavation below this depth was not feasible. This area was backfilled with SWTP-washed sands but was not restored to its original grade, as much of the soil washed material that originated from this area was used as clean backfill in the OU3 Blackwater Branch Phase I excavation.

More details about the implementation of the OU1 remedy can be found in the Remedial Action Report for OU1, which was finalized in 2015.

OU2:
The following actions have been implemented as part of the OU2 portion of the Site remedy:
A groundwater treatment plant and an extraction system was constructed and brought online in 2001. The system was designed to contain the contaminated groundwater being flushed by the original OU1 remedy. A total of 16 extraction wells were installed (Figure 3). After the soil flushing remedy for OU1 was changed to a soil washing remedy through the 2001 ESD, the extraction system and groundwater treatment plant continued to be operated in order to contain the contaminated groundwater, prevent it from reaching the Blackwater Branch, and to support long-term aquifer restoration. However, re-injection of the treated groundwater from OU2 was eliminated. Instead, all treated groundwater is discharged to the Blackwater Branch through an outfall west and downstream of the plant site. Wastewater from the OU1 soil washing facility, which was a closed loop system that recycled process water, was also sometimes sent to the OU2 groundwater treatment plant. The groundwater treatment plant can process between 1.1 and 1.3 million gallons of water per day.

In 2011, a Remediation System Evaluation (RSE) and modeling of the groundwater extraction system were conducted. Based on the findings of this work, several modifications to the system were recommended to improve capture and containment of the arsenic plume. From 2011 through 2014, significant efforts were made to develop a robust conceptual site model, and to model the plume in order to optimize the groundwater treatment plant (GWTP), with the goal of maximizing arsenic reduction/removal through pumping of the most highly contaminated portion of the plume while still maintaining plume capture and controlling the amount of water extracted from clean areas. Several extraction wells have been removed from the network, with only a small number of wells continuing in service. This reduction in GWTP pumping rates is a result of the RSE, focusing on immobilizing the arsenic in situ via the air sparge pilot study, rather than extracting groundwater and treating the soluble arsenic ex situ.

In September 2014, the operation and maintenance of the GWTP was transferred to NJDEP. The plant continues to operate, although the implementation of the pilot studies discussed previously required coordination with NJDEP to stop pumping in certain wells during periods. Since 2014, three extraction wells have been pumping at a total flow rate of 250-300 gpm.

OU3:
OU3 was split into two distinct phases, the Blackwater Branch, and the Maurice River. The remediation of the Blackwater Branch was further divided into four phases.

Blackwater Branch

The excavation and treatment of arsenic-impacted sediment from the Blackwater Branch and its floodplain were carried out in four phases from 2006 through 2012. Phase I encompassed the area east of North Mill Road and adjacent to the chemical plant site. Phase II encompassed the area west of North Mill Road and east of Route 55. Phase III encompassed the area west of Route 55 and east of the Maurice River Parkway. Phase IV encompassed the stream and floodplain west of the Maurice River Parkway to the Maurice River.

In each phase, the Blackwater Branch was diverted to a clean location before excavation of the contaminated material was performed. Once material with arsenic concentrations exceeding 20 milligrams/kilogram (mg/kg), the value identified in the 1989 ROD, was removed, the excavated area was backfilled with clean material and stream flow was restored to the reconstructed stream channel.

Soon after arsenic excavation in the floodplain of Phases 1 and 2 was completed in 2009, iron staining along the banks and within the Blackwater Branch was observed in certain locations. Sediment and seep water samples taken at a few of these iron-stained locations were analyzed in 2010 to determine if these iron-stained sediment also contained arsenic.

The sediment samples that were co-located with the seep samples contained arsenic just above the floodplain sediment goal of the 1989 ROD (20 mg/kg). These results provided evidence that arsenic is seeping into the Blackwater Branch floodplain in certain locations sampled even with the pump and treat system in operation, contaminating exposed sediment. The OU3 remedy was selected based on the assumption that groundwater discharging into the Blackwater Branch floodplain would not impact the exposed sediment.

Preliminary bench scale (laboratory) testing was conducted to evaluate the viability of in-situ treatment as a method of immobilizing the arsenic that was found to be discharging into the Blackwater Branch. In-situ treatments evaluated at the bench scale focused on creating conditions for which the accumulation of arsenic in sediment would be unfavorable either by reducing the movement of arsenic to the sediment/soil of the floodplain or by reducing the availability of areas onto which arsenic can accumulate through complexing with iron compounds in the sediment.

Results of the bench scale studies indicated that several methods of in-situ treatment can reduce arsenic accumulation in sediment/soil so that concentrations in the Blackwater Branch floodplain would remain below cleanup goals. These methods include in-situ treatment with oxygen (such as by air sparging or the use of peroxide), in-situ treatment with iron, and/or in-situ pH adjustment. In 2015, the air sparge pilot study was initiated at the site, by Area A, (see Figures 4, 5, and 6 for location and details), and the results of this have been successful within the zone of influence of the system. The system originally consisted of 4 mid-depth air sparge wells (AS-1 through AS-4), 2 shallow air sparge wells (AS-2U & AS-3U), 9 mid-depth and shallow monitoring well pairs (MP-1U\MP-1L to MP-9U\MP-9L) and one well monitoring well (MP-1D) screened between the banded zone and clay seam encountered below the iron stained / cemented sand. The configuration of the air sparge system is shown in Figures 5 and 6. Air sparge wells were located 30 feet apart based on a radius of influence of 15 feet estimated from the one well air sparge tests. The 2-ft screens of the mid-depth air sparge wells were located within the iron stained / cemented sand several feet above the banded zone to avoid oxidation of pyrite encountered in the banded zone.

In the summer of 2016, two additional mid-depth air sparge wells (AS-5 & AS-6) were added in the area where oxygen delivery was poor (based on a 2017 analysis of the system). The addition of these wells resolved the poor distribution of air, as demonstrated by dissolved oxygen along the south east portion of the zone of influence of the air sparge system. Results indicate that dissolved arsenic [As(D)] declined in monitoring wells within the air sparge system zone of influence.

Based on these promising results of the bench scale studies, the OU3 ROD Amendment described above was signed in 2016. The ROD amendment included: in-situ treatment, hot spot excavation, and monitoring. Design of the amended in-situ remedy is ongoing, however the hot spot excavation was not deemed necessary or effective at this time. In addition, OU6 of the site was initiated to more fully evaluate the ongoing contamination concerns from a holistic perspective. While the OU3 ROD Amendment selected an interim remedy for OU3, it is anticipated that OU6 will result in the selection of a final remedy for the site as a whole.

Maurice River

The 1989 ROD called for three years of monitoring the Maurice River, once the arsenic impacts had been controlled, to determine if natural river flushing would allow for the submerged, arsenic-contaminated sediment of the Maurice River to be flushed clean through natural processes. To evaluate this, sediment arsenic loading was evaluated over a three-year period between 2012 and 2015 in the Maurice River from the confluence with the Blackwater Branch to the upper reaches of Union Lake above the low head dam. Upstream (of the site) reference samples were collected on the Maurice River at Garden Road and the Blackwater Branch near North Delsea Drive. A draft report summarizing the results was submitted to EPA in October 2015. The majority of contamination was found in isolated hotspots in the lower parts of the Maurice River and in Union Lake. The arsenic flux rates at a sampling location upstream of the site were consistent, ranging from 63 to 158 kg/year. All stations but the upstream reference site on the Maurice River at Garden Road, had arsenic flux rates much lower in 2012 and 2014 compared to previous 1992/1993 data. Decisions about work or additional assessments of the Maurice River were paused address areas of the Blackwater Branch floodplain that show higher levels of arsenic in isolated area of sediments.

Overall, surface water sample analysis showed consistently higher total and dissolved arsenic concentrations collected in the lower stretches of the river close to and in Union Lake as compared to the upper stretches (beaches along the Maurice River and below the confluence with the Blackwater Branch) for both collection methods (disturbed and undisturbed). Disturbed samples are collected by first agitating the water in order to mimic human activity that may stir up sediment in to the water column; the water samples are collected before and after that disturbance. In the upper stretches of the river, average total arsenic concentrations for sample collection after disturbing the sediment ranged between non-detect and 3.85 µg/L to 9.8 µg/L at said beaches. Average total arsenic concentrations in surface water for disturbed sediment samples ranged from 5.3 µg/L to 10.29 µg/L and 5.43 µg/L to 6.52 µg/L at Union Lake beaches. All public beaches (officially closed by the City of Vineland most years due to *e.coli* contamination in the water) along the Maurice River and Union Lake are sampled for arsenic annually by EPA and monitored for human health risk concerns.

Several lines of evidence were available to assess the risk to aquatic receptors in aquatic habitat areas potentially impacted by arsenic from the Vineland Chemical Company Site. Total and dissolved arsenic concentrations in surface water were well below the chronic AWQC for aquatic life. Arsenic concentrations in fish tissue were below tissue concentrations reported to be associated with adverse effects on fish growth, reproduction or survival. Mortality observed in solid-phase toxicity tests was correlated with sediment arsenic concentrations. Only one line of evidence (the Hazard Quotient approach) was used to assess the risk to piscivorous birds and mammals exposed to arsenic present in sediment, surface water and prey tissue. This line of evidence suggests negligible risk from dietary exposure of piscivorous receptors to arsenic. The benthic invertebrate community is very diverse with high numerical abundance, and is indicative of a healthy and robust ecosystem. The community is largely composed of insect larva with smaller numbers of adult insects, crustaceans, mollusks and annelids. Highly diverse sensitive taxa (mayflies, stoneflies, and caddisflys) were present in samples collected in potentially impacted downstream areas. Multiple generations of long lived taxa were present suggesting that reproductive success is common and unimpaired. Dietary exposure models using arsenic concentrations measured in fish captured on-Site indicate no risk to upper trophic level receptors. Because the majority of the lines of evidence used to evaluate potential risk to ecological receptors in the Maurice River and Union Lake headwater area yield similar conclusions, confidence in the conclusion is greatly increased.

In mid-2015, a new site was added to the NPL, the Former Kil-Tone site, that also potentially contributes arsenic contamination to the Maurice River, but through the Tarkiln Branch rather than the Blackwater Branch. The investigation of that site is ongoing, but it is possible that full remediation of the Maurice River may require coordinated action at both sites. In spring 2021, a modeling expert began preliminary consideration of the development of a sediment transport model that incorporates inputs to the Maurice River from both branches.

It is anticipated that the OU6 holistic RI/FS will also help resolve some of the ongoing concerns related to the Maurice River. As work can only commence on the Maurice River once all concerns surrounding the Blackwater Branch are addressed, as per the 1989 ROD.

OU4

Interim remedy reevaluation to begin after the completion of OU3 and sediment model is completed for the Maurice River, taking into account loading from the two tributaries connected to the Vineland Chemical site and the Former Kil-Tone site.

OU5

OU5 was completed in 1994 and involved the demolition of the most highly contaminated Vineland Chemical Company buildings. All building contents and debris were disposed of at an approved offsite landfill.

OU6

OU6 fieldwork is anticipated to begin in the Summer of 2022.

Institutional Controls

In May 2007, EPA completed the process of having the area encompassing the arsenic-contaminated aquifer designated as a NJDEP/State of New Jersey Classification Exception Area with a Well Restriction Area (CEA-WRA). With this institutional control in place, the risk of uncontrolled exposure to the arsenic-contaminated groundwater has been greatly reduced. It is expected that the 2007 CEA will be updated before the next 5 year review.

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater	Yes	No	Block 172, Lots 1 – 6 Block 172, Lots 7, 8 Block 173, Lot 1 Block 174, Lot 7.03 Block 174, Lot 3	The installation of potable wells is restricted in the designated portions of the Cohansey Aquifer due to	Classification Exception Area/Well Restriction Area, May 2007

			Block 174, Lot 16 Block 139.01, Lot 16 Block 139.01, Lot 18 Block 142, Lot 1 Block 142, Lot 1.01 Block 147 Lots 1, 2 Block 148, Lot 7 Block 139, Lot 1 Block 139, Lot 2	arsenic concentrations that exceed the NJDEP MCL	

Systems Operations/Operation & Maintenance

As previously discussed, in September 2014 the operation and maintenance of the GWTP was transferred to NJDEP. The NJDEP contractors sample the GWTP effluent monthly, and the monitoring wells are sampled annually. This data is shared with EPA on an annual basis and is incorporated into the five-year review process. EPA/USACE also sample the monitoring wells annually.

Potential site impacts from climate change have been assessed, and the performance of the remedy is currently not at risk due to the expected effects of climate change in the region and near the site. The OU2 GWTP is outside the 500 year floodplain, however the area of the air sparge system is within the 100 year floodplain. There have been no significant impacts from flooding to the OU-2 GWTP since it began operating.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last five-year review as well as the recommendations from the last five-year review and the current status of those recommendations.

Table 1: Protectiveness Determinations/Statements from the 2016 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Short-term Protective	The remedy at OU1 currently protects human health and the environment because the contaminated soil has been excavated and replaced with clean backfill. However, in order to be protective in the long term, further investigations are needed to determine if residual soil contamination is a source to groundwater.
2	Short-term Protective	The remedy at OU2 currently protects human health and the environment because the groundwater remedy continues to capture most contaminated groundwater, ICs are in place to prevent any exposure, and no private wells exist near the site. However, in order to be protective in the long term, further investigations are needed, after the OU3 ROD Amendment is implemented, to evaluate restoration potential.

3	Will be Protective	The remedy at OU3 is expected to be protective of human health and the environmental upon completion. In the interim, remediation activities to address contaminated Blackwater Branch sediment have effectively removed and treated the sediment that resulted in unacceptable risks and fencing prevents exposure to residual contamination in this area.

Table 2: Status of Recommendations from the 2016 FYR

OU #	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
1	Potential continuing source of arsenic contamination in saturated soil beneath plant area.	Continue investigations into residual arsenic to determine if and how it may impact groundwater	Ongoing	As part of the OU6 RI/FS, further investigations are ongoing to more clearly understand the nature and extent of arsenic not remediated. Arsenic below the water table was not previously addressed through remedial action.	N/A
2	Groundwater MCL for arsenic has changed since ROD. ROD cleanup goal = 50 ppb; federal MCL = 10 ppb; state MCL = 5 ppb; state groundwater quality criteria = 3 ppb.	Evaluate current groundwater and surface water standards to determine if new cleanup goals are needed and optimize/enhance groundwater extraction and treatment system to meet new goals, if possible.	Ongoing	Since the groundwater P&T was transferred to NJDEP in 2014, further modifications to the GW extraction system to achieve GW ARARS have been under the jurisdiction of the State. GWTP effluent remains below 10 ppb and often below 5ppb. Information developed through the RI/FS process for OU6 will be used to determine if achieving the current MCL for arsenic is technically feasible.	N/A
2	Discrete areas of groundwater contamination potentially not being captured by existing extraction system.	Implement ROD amendment activities to protect sediment of the Blackwater Branch and evaluate impacts on groundwater plume extent.	Ongoing	The 2016 ROD amendment for OU3 addressed one area of concern (Area A) by implementing an air sparge pilot study in order to immobilize arsenic in the groundwater and prevent recontamination. Upcoming work performed as part of the OU6 RI//FS process will be used to help identify areas of concern for	N/A

				potential future remedial action. Groundwater concentrations indicate the plume is not expanding.	
2	Evaluate arsenic geochemistry and associated impacts on groundwater quality data.	Evaluate arsenic geochemistry and associated impacts on groundwater quality data.	Ongoing	The arsenic soil geochemistry is complex and varies throughout the site and interacts with the groundwater. The OU6 RI/FS will address data gaps.	N/A
2	Groundwater ICs established based on MCL at time of ROD.	Update institutional controls (2007 CEA-WRA) for groundwater once the immobilization remedy has been implemented.	Ongoing	An updated CEA will be put in place before the next five year review. The current CEA extends 100 ft from outer MWs and to a vertical depth of 250 ft.	N/A
2	Groundwater data appear to corroborate the earlier RSE finding that the rate of decreasing concentration has slackened so that the present P&T system is not likely to restore the aquifer within a time period envisioned by the OU2 ROD.	Once immobilization remedy has been implemented, evaluate groundwater and residual source area to assess restoration potential.	Ongoing	This concern will be primarily addressed through the upcoming OU6 RI/FS investigation and was partially addressed through the implementation of the air sparge system via the OU3 ROD amendment.	N/A

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

On September 22, 2020, EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanups and remedies at Superfund sites in New York, New Jersey, Puerto Rico and the U.S. Virgin Islands, including the Vineland Chemical Superfund site. The announcement can be found at the following web address: https://www.epa.gov/superfund/R2-fiveyearreviews.

Once the five-year review is completed, the results will be made available on the EPA Vineland Chemical website, at: https://www.epa.gov/superfund/vineland-chemical

During the FYR process, interviews were conducted to document any perceived problems or successes with the remedy that has been implemented to date**.** Discussions were held with the USACE to assess the data collected for OU1, OU2, and OU3.

Data Review

OU1

Since the OU1 remedy was implemented, there have been multiple soil boring investigations that delineated areas of arsenic concentrations above 20 mg/kg. The results show that there is an area of arsenic impacted soil in the former source area that extends north and west to the Blackwater Branch. An area south of Blackwater Branch and west of Mill Road around Ponds 1 and 2 also shows elevated concentrations. However, the arsenic mass is principally in the saturated zone outside of the OU1 remedy, which is at a depth of 40 to 70 ft bgs.

OU2

Since 2014, the extraction system has consisted of three extraction wells screened in the shallow aquifer and one in the mid-depth aquifer. The combined flow rate is 250-300 gpm. From 2016 to 2020, total arsenic in the treatment system effluent was measured one to two times per month. The concentrations ranged from non-detect to a maximum of 9.10 µg/l in December 2017. In 2020, total arsenic was detected in effluent in five of sixteen events, and the concentrations ranged from 3.1 to 4.20 µg /l.

Shallow groundwater flow is generally to the west but influenced by Blackwater Branch and the extraction wells. In both the shallow and mid-depth aquifers, there are individual wells with concentrations below 50 µg /l, but the area of concentrations above 50 µg /l generally extends from east of the former source area, west toward Mill Road, north past the Blackwater Branch, and southeast toward the area of the former soil washing plant.

Concentrations of arsenic in the shallow wells are generally stable or declining. In this five-year review period, arsenic concentrations did increase at shallow well MW74S (next to Blackwater Branch), PZ11, and PDP21 (near the air sparge system). The highest concentration of arsenic measured in the shallow wells in this period was in the southeast area of the plume, 1180 µg /l at MW67S in June 2017.

The mid-depth groundwater flow is also generally to the west. The mid-depth plume has a similar extent to the shallow plume but does not extend as far south. During this review period, arsenic concentrations in the mid-depth monitoring wells were mostly stable or declining. Arsenic increased at well MW73M, located downgradient of an arsenic soil hot spot. The maximum concentration of arsenic at MW73M in this period was 13,800 µg /l in 2019, but in 2020 the concentration declined to 2000 µg /l at this well. Six other mid-depth wells in the northwest area of the plume also showed increasing concentrations from 2016 to 2020.

Deep wells were sampled annually in 2018, 2019, and 2020. Of the deep wells sampled, all results were non-detect, except for EW-07D, which had 1 µg/l of As in 2019.

OU3

Following excavation work in the floodplain, results from sampling of seeps before 2016 indicated that exposed floodplain soils near the Blackwater Branch have become re-contaminated with arsenic in certain areas.

Before 2016, arsenic in sediment along the Blackwater Branch exceeded the criteria of 19 mg/kg in six out of seven sampling events, at times contiguously across an approximately 300-ft-long segment of the branch located east of Mill Road and downstream of the bend. In the six sampling events conducted between 2017 and 2019, arsenic exceeded 19 mg/kg in four of the events, but only in a few isolated locations. It is not clear whether the improved sediment conditions, as compared to those encountered in summer 2016, are due to: 1) stream restoration completed in summer 2012, 2) the groundwater treatment plant operating under current pumping rates since winter 2015, 3) the decline in arsenic in pore water and groundwater, or 4) some combination of all of the above. The 1989 ROD (human health risk) criteria of 120 mg/kg for submerged sediments in the river and lake areas was not exceeded in any of the samples collected after 2013, and before 2013 this criteria was exceeded in a few isolated locations.

The July 2020 sediment sampling showed elevated concentrations at two locations in the Blackwater Branch. The sample from the 2350N location had 27.7 mg/kg of arsenic, and is located close to where high porewater concentrations are found. The sample from location 225S is downstream of the air sparge system and the ponds, and its concentration was slightly elevated at 19.2 mg/kg.

Pore water was sampled annually to evaluate groundwater discharge into the Blackwater Branch. Sampling was performed in well point transects along three segments of the stream. Area C (see Figure 4) includes the Blackwater Branch downgradient of the pumping wells and closest to the former source area. Arsenic concentrations along Area C generally declined in this period, but two transects exceeded 350 µg/l in July 2020. Arsenic in the well points along Area B, downstream of Area C, declined to below 350 ug/l in 2019. In Area A, most well points declined in this period, but two locations increased to exceed 350 µg/l in 2018. However, the pore water arsenic concentrations are variable from year to year. For example, in 2018, transect WP2400 in Area C had two locations with 1300 and 1450 µg /l arsenic that both declined to 1 µg /l in 2019.

Surface water sampling is performed semiannually or annually in the Blackwater Branch, ponds, and seeps. Since 2016, arsenic concentrations in surface water exceeded 50 µg /l at one location along Area B in May 2019, and along Area C at two locations in May 2019, possibly related to elevated base flow in spring 2019. One location at the confluence of the Blackwater Branch and the Maurice River was elevated in August 2018.

Higher arsenic concentrations are found in the ponds and seeps. The sampled ponds located in Phase 2 of the BWB (see Figure 4) are located along the north and south sides of the Blackwater Branch close to the area of the air sparge system. Arsenic concentrations in the ponds seem to fluctuate seasonally. Pond 3, on the north side of the branch, exceeded 50 µg /l in 2016 and 2017. Pond 2, on the south side, exceeded 50 µg /l in most events. The discharges of Pond 2 into the Blackwater Branch were also elevated above 50 µg /l in most events. In July 2020, the arsenic concentration in Pond 2 was 158 µg /l.

The sampled seeps are located close to Area C of the Blackwater Branch and along the branch in the downstream area west of Mill Road. Arsenic concentrations are frequently above 50 µg /l. The concentrations and the size of the seeps fluctuate in response to seasonal effects. In May 2019, the highest concentration of arsenic measured in a seep was 3,300 µg /l, at seep location 2500s close to Segment C of the Blackwater Branch. By December 2019, this concentration had declined to 1.5 µg /l.

The groundwater data show that the plume is generally stable. But pore water results show that there are areas of the plume that are discharging concentrations above 350 µg /l, particularly around Area C. The

Blackwater Branch does not frequently exceed the surface water criteria, but the ponds and seeps are impacted by the high arsenic concentrations in groundwater, particularly around Segment C of the Blackwater Branch and Pond 2.

The large-scale pilot air sparge system started operating with shallow and mid-depth sparge wells in 2015. Arsenic concentrations in the shallow wells declined to below 10 µg /l by 2016, and the shallow air sparge wells were removed from operation due to the success of the air sparge system. From 2015 to 2019, almost all of the mid-depth wells within the zone of influence declined to below 350 µg /l and most wells were below 50 µg /l.

Site Inspection

Due to health and safety considerations from the COVID-19 pandemic, a site inspection was not completed by the review team during the review period. In lieu of a site inspection, email and phone conversations between Nica Klaber (RPM) and Steve Creighton (USACE) and Erin Husta (NJDEP) were used to document the current status of operations at the site, as well as a walk-through conducted by USACE. Nothing of significance was noted during these conversations, however USACE found that repairs to the fencing around OU3 are needed; otherwise the site is being operated and maintained appropriately. This is consistent with previous visits by EPA to the site. A formal site inspection by the review team will be scheduled when it is determined to be safe to do so.

V. TECHNICAL ASSESSMENT

QUESTION A: *Is the remedy functioning as intended by the decision documents?*

As noted above, the remedies for the Vineland Chemical Company are being implemented in four discrete phases (see Figure 2). OU1 and OU2 have been implemented. The Blackwater Branch portion of the OU3 that involved the excavation of the floodplain soils and the restoration of the Atlantic White Cedar wetlands has been implemented, whereas the Maurice River portion of OU3 will be implemented in later phases so that up-gradient contamination from another Superfund site can be addressed first. Under the OU3 ROD Amendment, the air sparge has been implemented and is currently operating near Area A (see Figure 4).

The OU1 excavation and treatment of site soil began in 2003 and was completed in late 2007. Site buildings that were pervaded by arsenic contamination were demolished and the building materials disposed off-site. The objectives of the soil remedy have been met in that contaminated soil located in the unsaturated zone was successfully remediated, thereby reducing the potential for direct contact as well as reducing the arsenic impact on groundwater. However, additional soil contamination in the deeper saturated zone was not part of the OU1 remedy and was not addressed. Consequently, arsenic-impacted soil that remains in the saturated zone is a continuing source of arsenic contamination to groundwater. An RI/FS for OU6 was recently initiated that will take a holistic view of the site, as this OU encompasses the interactions between groundwater and the saturated soil containing arsenic. The arsenic in the subsurface soil comprises an on-going source of arsenic to porewater, groundwater, soil, sediment, and surface water associated with OU3.

Arsenic-contaminated groundwater is managed by the OU2 remedy, which involves extraction and treatment. The GWTP system began operating in 2001; and based on periodic water-quality and hydrologic-head assessments, the system has been performing as designed. For the most part, the GWTP system captures (contains) the groundwater arsenic plume exceeding 350 ppb (ROD criterion), and has reduced arsenic contaminant levels in groundwater and prevented the migration of arsenic to the Blackwater Branch. While the plant has been operating properly, groundwater arsenic levels in the aquifer have not achieved the remediation goal, possibly as a result of residual contamination in soils as arsenic is likely found in localized pockets of sedimentary material in the aquifer. The GWTP was optimized, and since 2015, now operates at less than one third of the capacity of previous years flow rates.

The excavation and treatment of arsenic impacted sediment from the Blackwater Branch and floodplain (OU3) was implemented in four phases from June 2006 through December 2012. In each phase, the Blackwater Branch was diverted to a clean location prior to performing the excavation of the contaminated material. All material with arsenic concentrations exceeding 20 mg/kg was removed; subsequently, the excavated area was backfilled with clean material and stream flow was restored to the re-constructed stream channel. The OU3 remedy, based on the 1989 ROD, was selected based on the assumption that the flow of arsenic-contaminated groundwater into the Blackwater Branch will have been stopped by the GWTP system. The OU3 remedy was modified in 2016 to include the air sparge in situ- treatment to immobilize the arsenic in groundwater as it surfaces in the sediment (by enhancing the co-precipitation with iron, thereby immobilizing it in the sediment), and preventing the arsenic from reaching the Blackwater Branch. The air sparge pilot study has been successfully implemented (see Figure 5 and 6) which has significantly reduced arsenic concentrations in the zone of influence for this pilot scale study. The air sparge pilot study is currently operating, and will be evaluated for an expansion to a full size operation as part of the amended OU3 remedy. The air sparge, coupled with the GWTP, has reduced impacts to the Blackwater Branch; although, as discussed below, isolated exceedances of cleanup goals exist in some areas of the OU3 floodplain. Additional studies being performed as part of OU6 will help to understand the fate and transport of arsenic from groundwater to surface water and sediment.

ICs remain in place in the form of a CEA/WRA, which encompasses the arsenic contaminated aquifer and has been in place since May 2007. The purpose of this IC is to prevent human exposure to contaminated groundwater.

QUESTION B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

There have been no physical changes to the site that would adversely affect the protectiveness of the remedy. Land use assumptions, exposure assumptions and pathways and RAOs considered in the decision documents remain valid. Although specific parameters have changed since the time the risk assessment was completed, the process that was used remains valid.

The remedy for OU1 was the closing of surface impoundments, cleaning the chicken coops and excavation and treatment of on-site soil. A cleanup goal of 20 mg/kg was selected, which was consistent with the interim state background arsenic level at the time of remedy selection. The New Jersey promulgated background level has since slightly dropped to 19 mg/kg, however the OU1 remedy remains protective of human health because the cleanup level is still within the Superfund target risk range for a residential receptor.

The OU2 remedy involves containment and restoration of groundwater to its designated use as a drinking water source. At the time of the ROD, the MCL for arsenic was 50 µg/L. Since then, EPA has revised the arsenic MCL to 10 µg/L; New Jersey revised its MCL to 5 µg/L and also established a groundwater quality standard of 3 µg/L. The GWTP has been operating under current conditions since 2015, based on recommendations of the 2011 Remedial System Evaluation (RSE) to optimize pumping, achieve plume containment, and for groundwater treatment consistent with the state discharge to surface water quality criteria. To prevent human exposure to contaminated groundwater, an institutional control in the form of a CEA was put in place in 2007. Although there are plans to expand the CEA, there are currently no known private drinking water wells in the vicinity of the site that could be impacted by a potentially expanded plume. Any decisions to modify the groundwater remedy will take into consideration these newly promulgated standards.

At the time of the ROD, a surface water goal of 50 µg /L was identified consistent with the federal drinking water MCL based on the assumption that surface water could represent a future source of drinking water. The groundwater pumping/extraction system is effectively reducing most surface water arsenic levels in the Blackwater Branch to well below the standard of 50 µg/L identified in the ROD. All effluent samples from the five-year review period also achieved the federal drinking water standard MCL of 10 µg/L, with few exceedances of the NJ MCL of 5 µg/L. Since the Blackwater Branch is not currently used as a drinking water source, the remedy remains protective despite these exceedances.

The remedy for OU3 includes dredging arsenic-contaminated sediment from the Blackwater Branch and floodplains, and, the removal of contaminated sediments from the Maurice River after a three-year flushing period A three-year study of the Maurice River was completed in 2015, however additional work on the river is on hold until work on the nearby Kil-Tone site is resolved. The remediation goal selected for exposed sediment was 20 mg/kg, and is now 19 mg/kg after the OU3 ROD amendment. This value was consistent with the New Jersey interim background level at the time of remedy selection, and remains protective of human health though the promulgated background level decreased slightly to 19 mg/kg. A screening-level risk evaluation was conducted of the post-excavation sediment data in March 2016 which found that future recreational exposure to Area A of the Blackwater Branch would result in unacceptable cancer risk and noncancer hazards. Despite the remaining cleanup level exceedances, fencing currently restricts access to the Blackwater Branch and it is inaccessible for recreational use. The ongoing OU6 investigation will evaluate the extent of the remaining contamination and remedial options to ensure long-term protectiveness.

Annual evaluations of surface water and sediment data collected from six recreational areas in and around OU3 Maurice River and Union Lake through 2020 showed that current recreational use would not present unacceptable risks or hazards. These areas continue to be sampled and monitored on an annual basis to ensure that the OU3 contamination is not migrating downstream.

An exposure pathway that was not considered at the time of the original risk assessment is vapor intrusion into indoor air. Since volatile organic compounds (VOCs) or other vapor forming chemicals are not of concern in soil or groundwater at this site, vapor intrusion would not be anticipated.

Ecological

An ecological evaluation was performed for the 2016 ROD Amendment for OU3; this evaluation assessed the potential for ecological risk in the Blackwater Branch and the floodplain soil/sediment. In this evaluation, maximum concentrations of arsenic in the Blackwater Branch floodplain were found to exceed the site cleanup level of 19 mg/kg for arsenic in exposed sediment/soil. However, excluding sampling in the vicinity of seeps, 2019 exceedances in sediment were limited to only two locations, and the mean concentrations were less than 19 mg/kg on a reach basis. Exceedances in the ponds and seeps in Phase 1 and 2 of the BWB will be evaluated for risks to ecological risk receptors as part of the OU6 RI.

The floodplain soil is considered to be representative of a terrestrial environment, thus concentrations of arsenic were compared to EPA's Ecological Soil Screening Level (Eco-SSLs), which are concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil. As such, these values are presumed to provide adequate protection of terrestrial avian and mammalian receptors. The EPA Eco-SSLs for arsenic are 18 mg/kg for plants, 43 mg/kg for avian receptors and 46 mg/kg for mammalian receptors. Comparison of these screening levels to the 1989 ROD goal of 20 mg/kg (later 19 mg/kg in the ROD Amendment) for arsenic indicates this value is protective for avian and mammalian receptors. The only ecological value that is lower than 20 mg/kg is the value that was derived to be protective to plants (18 mg/kg). However, 18 mg/kg is below what is considered background for arsenic (20 mg/kg in 1989, 19 mg/kg currently) and is not considered achievable under site-specific conditions. In total, only three exceedances of the 43 mg/kg Eco-SSL values for avian receptors were detected in 2019, and on average, soil concentrations were approximately 16.25 mg/kg, below the background level for arsenic. Because the home range for an avian or mammalian population would be larger than the areas with elevated arsenic concentrations, it is unlikely that soil would pose a risk to ecological receptors. Furthermore, surface water concentrations remained below the chronic Ambient Water Quality Criteria (AWQC) of 150 µg/L and therefore is unlikely to pose risk to ecological receptors. While the 1989 ROD 120 mg/kg clean-up level for submerged sediments was originally derived from calculations to be protective of human health risk, this number remains protective of ecological receptors.

Although the remedial alternatives consisted of removing contaminated sediment and soil, recent data indicates that recontamination is occuring in localized areas which could impact ecological receptors in the future. The current data suggests that the concentrations of COCs in the sediment are currently acceptable. While some soil concentrations are elevated in localized areas, the average concentrations across the site are much lower. Additional investigation and evaluations should be completed as part of OU6 to address the recontamination of the sediment. The implemented remedies are controlling migration to an extent that there is not currently unacceptable risk to human health or ecological receptors.

QUESTION C: *Has any other information come to light that could call into question the protectiveness of the remedy?*

No other new information has come to light.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU3

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 01	Issue Category: Remedy Performance Residual Source Material			
	Issue: Potential continuing source of arsenic contamination in saturated soil beneath plant area that is impacting groundwater, as well as sediment and surface water in limited areas.			
	Recommendation: Continue OU6 investigations into residual arsenic to determine if and how it may impact groundwater.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	5/29/2026

OU(s): 02	Issue Category: Other ARARs			
	Issue: Groundwater MCL for arsenic has changed since ROD. ROD cleanup goal = 50 ppb; federal MCL = 10 ppb; state MCL = 5 ppb; state groundwater quality criteria = 3 ppb.			
	Recommendation: Information developed through the RI/FS process for OU6 will be used to determine if achieving the current MCL for arsenic is technically feasible.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA/State	5/29/2026

OU(s): 02	Issue Category: Remedy Performance			
	Issue: Evaluate arsenic geochemistry and associated impacts on groundwater quality data and migration to surface water and sediment.			
	Recommendation: Evaluation of arsenic geochemistry and associated impacts on groundwater quality data will be carried out in OU6			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	5/29/2026

OU(s): 02	**Issue Category: Institutional Controls**			
	Issue: Groundwater ICs established based on MCL at time of ROD.			
	Recommendation: Update CEA-WRA for groundwater consistent with current drinking water standards.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	5/29/2026

VII. PROTECTIVNESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: 01	*Protectiveness Determination:* Short-term Protective	*Planned Addendum Completion Date:* Click here to enter a date
Protectiveness Statement: The remedy at OU1 currently protects human health and the environment because the contaminated soil has been excavated and replaced with clean backfill. In order to be protective in the long term, further investigations are needed to determine if residual soil contamination is present and if it is a source to groundwater.		

Protectiveness Statement(s)		
Operable Unit: 02	*Protectiveness Determination:* Short-term Protective	*Planned Addendum Completion Date:* Click here to enter a date
Protectiveness Statement: The remedy at OU2 currently protects human health and the environment because the groundwater remedy continues to capture most contaminated groundwater, ICs are in place to prevent any exposure, and no private wells exist near the site. In order to be protective in the long term, information developed through the RI/FS process for OU6 will be used to determine 1) if and how residual arsenic may impact groundwater 2) if achieving the current drinking water standards for arsenic is technically feasible, 3) arsenic geochemistry and associated impacts on groundwater. Additionally, the CEA-WRA needs to be updated.		

Protectiveness Statement(s)		
Operable Unit: OU3	*Protectiveness Determination:* Will be Protective	*Planned Addendum Completion Date:* Click here to enter a date
Protectiveness Statement: The remedy at OU3 is expected to be protective of human health and the environmental upon completion. In the interim, the air sparge pilot technology, coupled with the GWTP, is significantly reducing impacts to the Blackwater Branch and fencing prevents exposure to residual contamination in this area. The implemented remedies are controlling migration to an extent that there is not currently unacceptable risk to human health or ecological receptors.		

VIII. NEXT REVIEW

The next five-year review report for the Vineland Chemical Company Superfund Site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

Focused Feasibility Study Vineland Chemicals Superfund Site Operable Unit Three (River Areas Sediments), Vineland, New Jersey, EPA ID: NJD002385664, Prepared by USACE, July 2016.

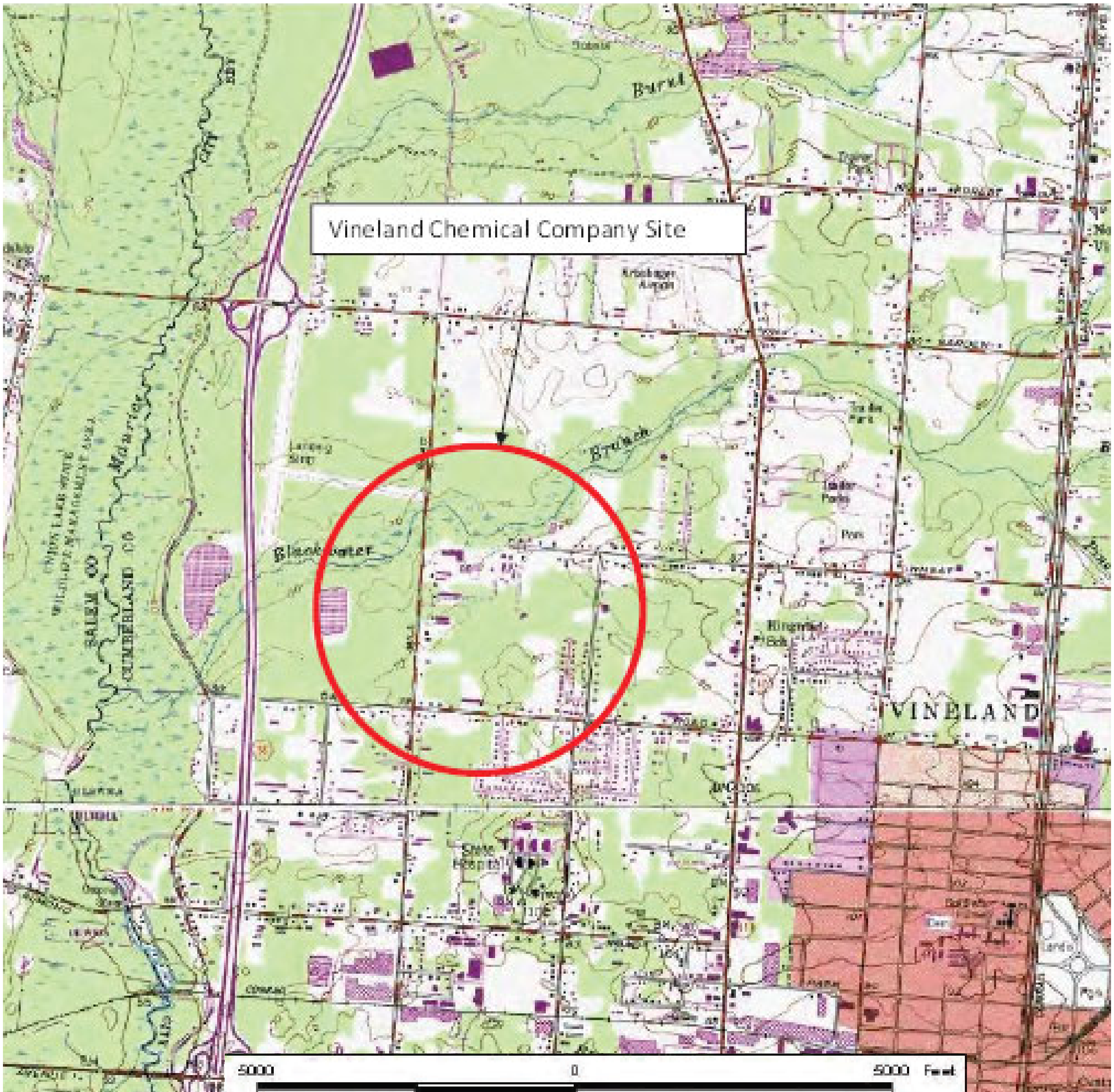
Remediation System Evaluation, Vineland Chemical Company Superfund Site, prepared by GeoTrans, Inc. for the U.S. Army Corps of Engineers, Philadelphia District, March 2011.

Vineland Chemical Post-2011 RSE Investigations and Findings Data Summary Report prepared by the U.S. Army Corps of Engineers, Philadelphia District, May 2020

Investigation of a Sustainable Approach to In-situ Remediation of Arsenic Impacted Groundwater; USEPA Office of Research and Development Center for Environmental Solutions & Emergency Response U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-19/102, 2019.

June/July 2020 Sampling Summary Report Vineland Chemical Company Superfund Site, Vineland, New Jersey. Prepared by U.S. Army Corps of Engineers Philadelphia District, November 2020

APPENDIX B – FIGURES

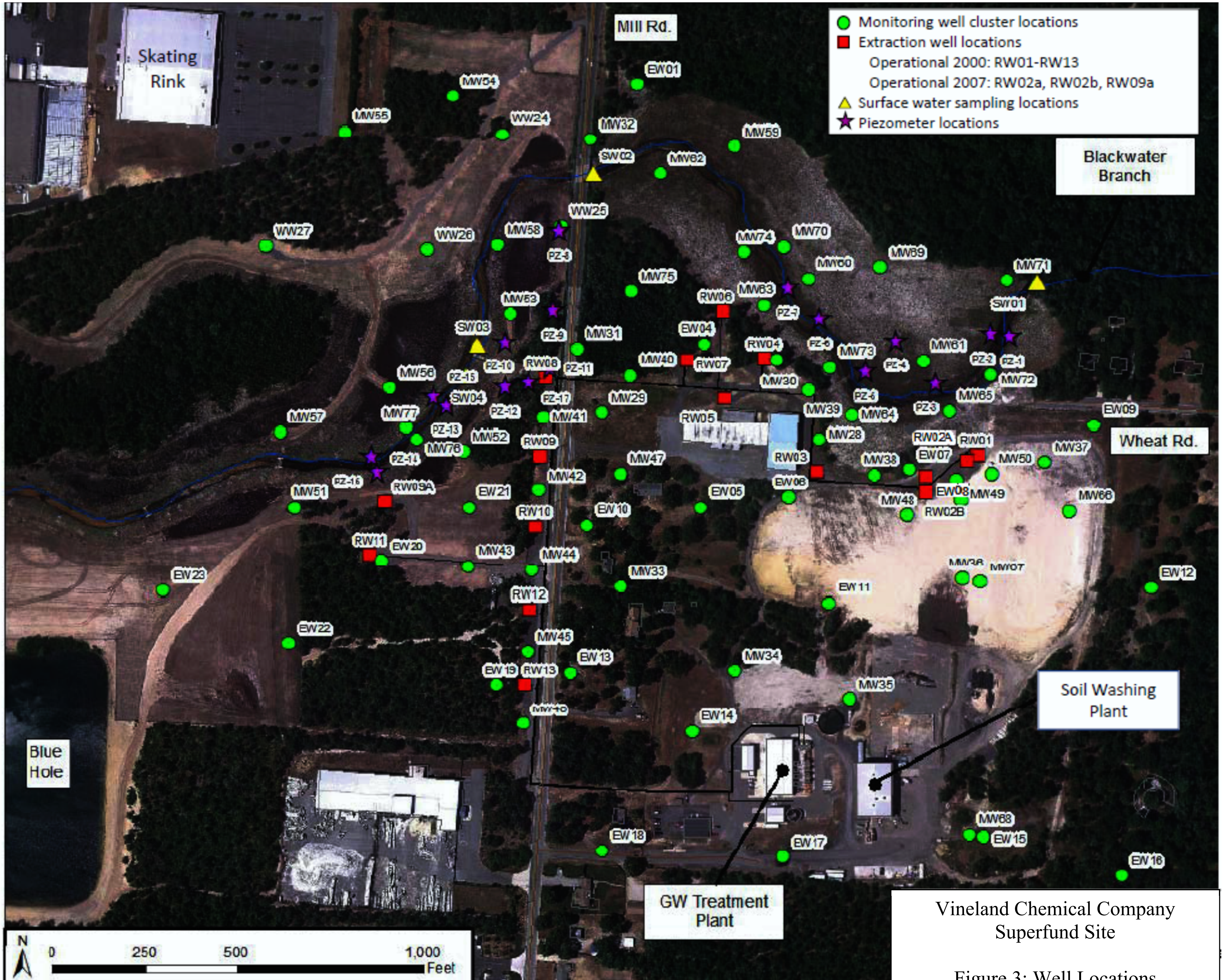


Vineland Chemical Company
Superfund Site

Figure 1: Site Location

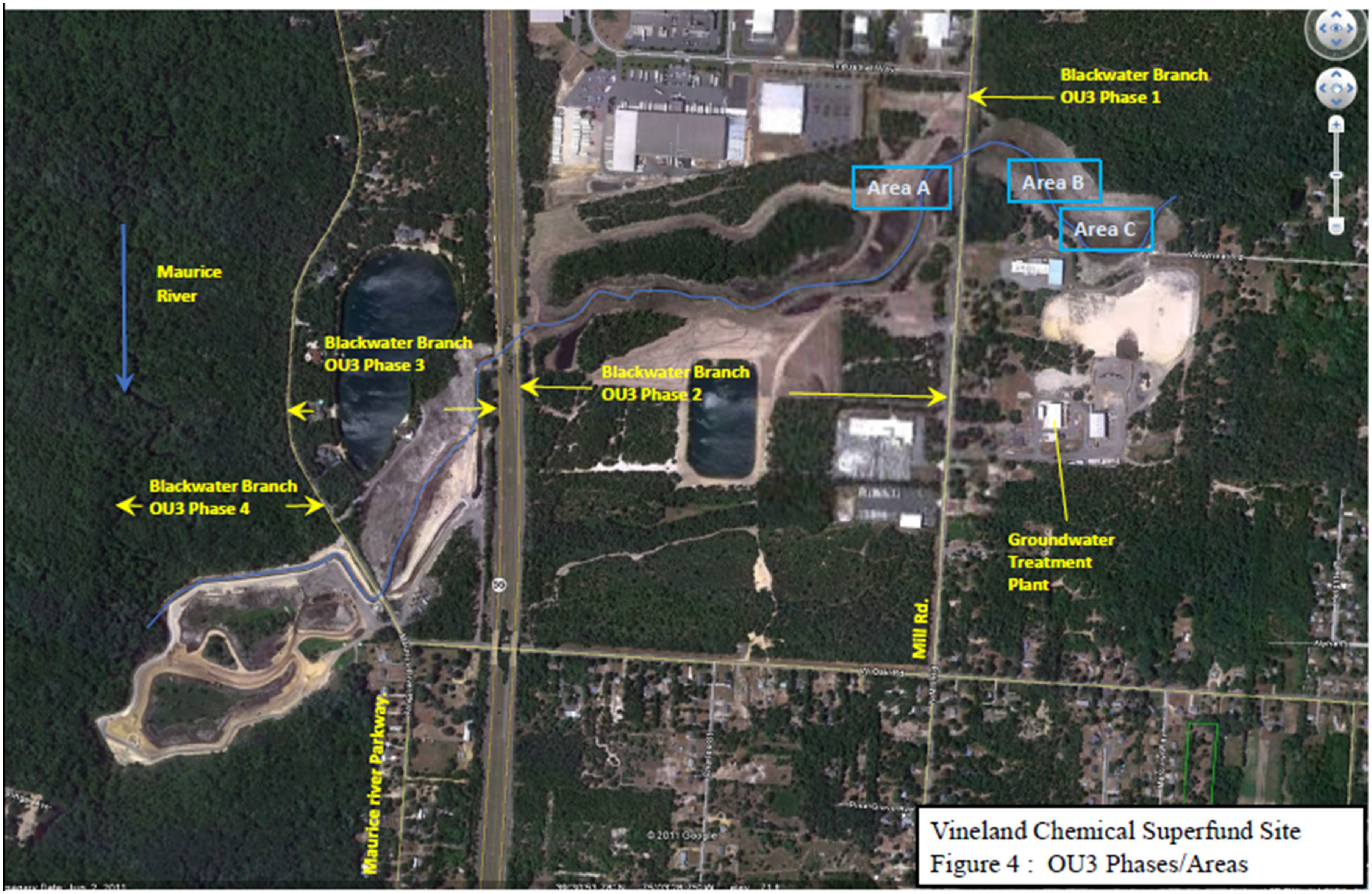
Vineland Chemical Company
Superfund Site

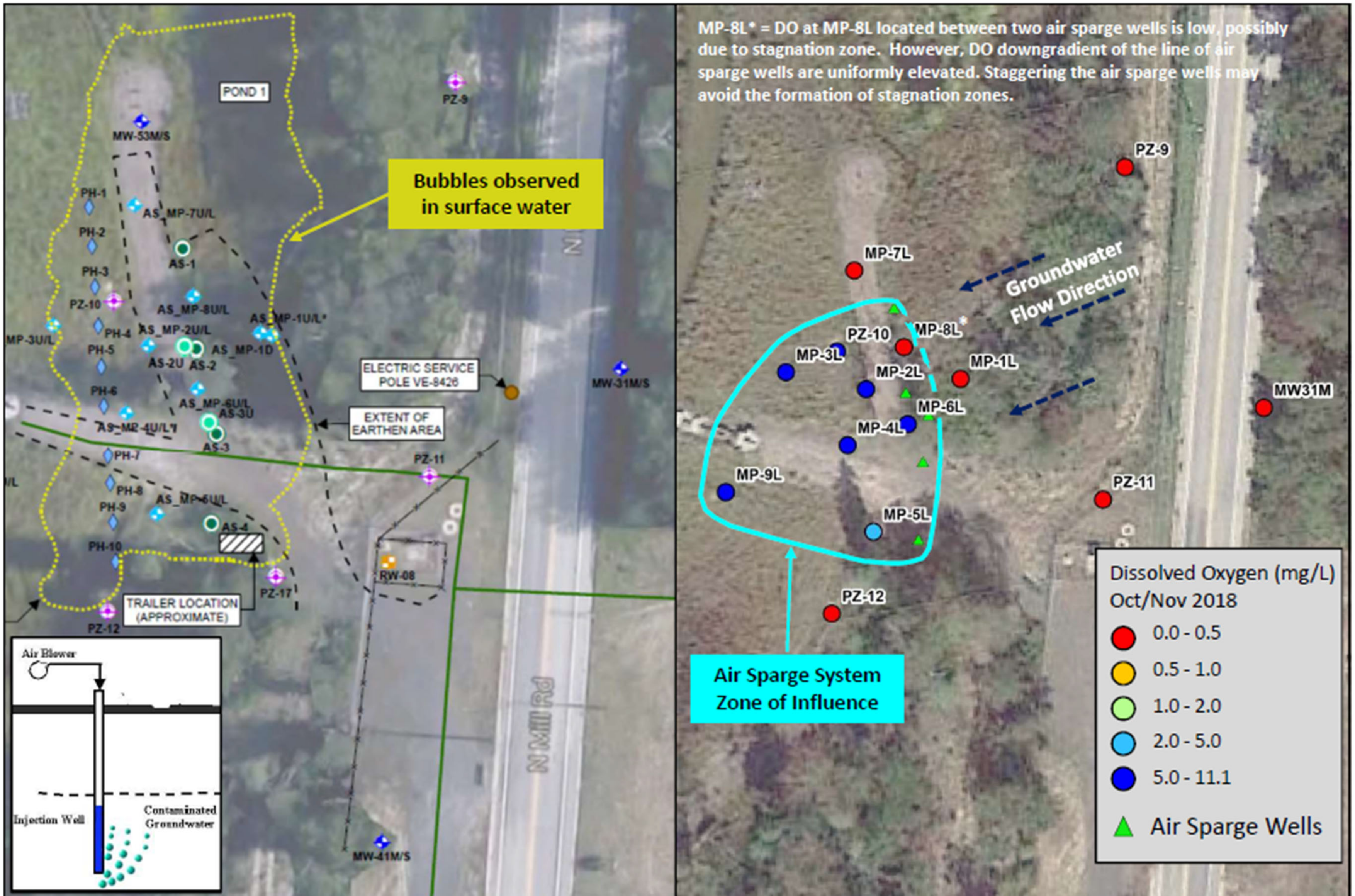
Figure 2: Operable Units



Vineland Chemical Company
Superfund Site

Figure 3: Well Locations


Blackwater Branch
OU3 Phase 1
Area A
Area B
Area C
Maurice
River
Blackwater Branch
OU3 Phase 3
Blackwater Branch
OU3 Phase 2
Blackwater Branch
OU3 Phase 4
Groundwater
Treatment
Plant
Mill Rd.
Maurice river Parkway
© 2011 Google
Vineland Chemical Superfund Site
Figure 4 : OU3 Phases/Areas



Air Sparge Zone of Influence - AS-1 through AS-6
Operating at ~ 65 scfm
Surface Air Bubble Observations and Zone of Influence

Figure 5

April 2019

Figure 6: Detailed Air Sparge Schemactic